The Predictor

Iteration 3 Substep 1 **June 1996**

A NEWSLETTER FOR THE NPARC USERS ASSOCIATION

From the Support Team

The third major version of NPARC is available. We think you'll find the enhancements in block interface specification, dynamic memory and coarse-grain parallel operation worth the wait. We've also redesigned the look of our WWW home page and included additional validation and example cases. We are also in the process of revamping email and telephone user support to be more responsive. As the lead article in this edition of the NPARC newsletter suggests, we are committed to continued support, development and validation of the NPARC CFD code and utilities.

To let us know what you think or for support questions, the NPARC support team can be contacted at:

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phone:
(615)-454-7455

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http://info.arnold.af.mil/nparc

What's Inside

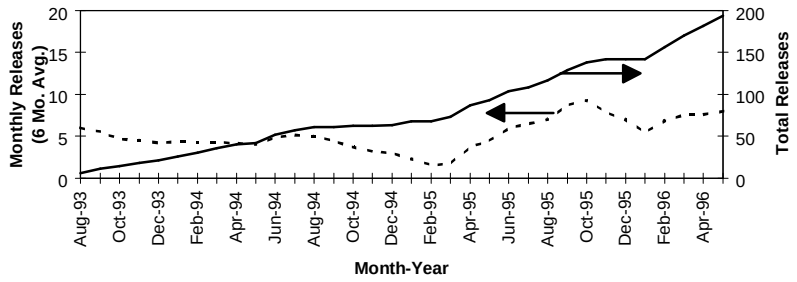
NPARC - Stability in the Midst of Change

Jere Matty AEDC/Joe Shaw LeRC

The NPARC Alliance began with a chance meeting between Joe Shaw and Jere Matty at a government short course in March of '92. By September of '93 a Memorandum of Understanding was signed between NASA Lewis Research Center (LeRC) and the Air Force's Arnold Engineering Development Center (AEDC) formally establishing the NPARC Alliance. Since that time the Alliance has worked very hard to maintain the viability of the Alliance structure and provide value-added services to the NPARC user base. To that end, the Alliance has accumulated such accomplishments as:

- One NPARC Alliance Workshop
- Three Major Releases of the Code

NPARC Release History



- Four NPARC Users Association Meetings
- Five NPARC Technical Sessions at AIAA meetings
- 194 Code Releases to US organizations
- 3232 Hits on the NPARC Home Page

Major changes have taken place at both LeRC and AEDC since the Alliance was formed. Along with the U.S. Aerospace Industry, both NASA and the Air Force have had to respond to significant budget cuts. LeRC is greatly reducing the number of Support Service Contractors (SSCs) and AEDC has combined it's technical support contracts to save costs. In spite of these cutbacks, however, support for the Alliance remains strong at both Centers. The Alliance is making plans to incorporate the best capabilities of the XAIR (another derivative of the Ames Research Code modified by the Calspan/AEDC group) code into NPARC as well as the NASTD technology from McDonnell Douglas. We are also investigating the possibility of incorporating unstructured and aeroelastic solvers under the NPARC umbrella. The Air Force Office of Scientific Research (AFOSR) has also been contacted to investigate ways to incorporate their CFD research into the Alliance. We are currently working the details for the second NPARC Alliance Workshop to be held at AEDC the last week in August to chart our course for FY97 and beyond. We are also planning technical paper sessions at both the AIAA Joint Propulsion Conference in Orlando in July as well as the Aerospace Sciences Meeting in Reno in January 1997.

Since it's inception almost three years ago, the NPARC Alliance has undergone significant change. But the simple vision of the Alliance has always been to develop:

A tool of choice for Aerospace Flow Simulation

The pursuit of that vision has provided our users and developers a measure of stability in the midst of change.

Parallelizing NPARC: Teaching An Old Flow Simulator New Tricks

The NPARC flow simulation computer program has gone through a number of major upgrades since its conception in the mid-eighties (mid-seventies if you count its ARC code parentage). Few of these previous program enhancements were as challenging as the recent incorporation of distributed computing technology. Compounding the complexity of this upgrade was the near simultaneous enhancement of the grid blocking methodology to allow for abutting (non-overlapped) blocks and generalized grid block overlaps.

The abutting grid block capability was included to handle a (common) situation in which the grid generation tool produces grid blocks which share common interfaces on the outer sides of the blocks. Earlier versions of NPARC could not properly handle this situation since the block interface methodology assumed a minimum amount of block overlap. A generalization of the grid block overlaps was desirable to simplify the treatment of problems where multiple blocks overlapped in the same region or where block overlaps did not pair up one-to-one. This new capability can handle arbitrary block overlaps with the two restrictions that non-flow regions must be excluded in all blocks and that the overwhelming majority of interface points are clearly within the interior of at least one grid block. Both of these new blocking techniques not only achieved their design objectives, but have proven to be very valuable enhancements in the application of the NPARC flow simulator.

As mentioned previously, parallelization of NPARC proved to be quite challenging. The chosen approach was to use the master-worker (master-slave) paradigm within the confines of a single source code. Since a design requirement for this implementation was to execute successfully on as many different computer platforms and parallel virtual machines as possible, the interfaces to the parallel library and the operating system were abstracted and a set of interface routines developed. It also proved expedient to perform most of the initialization of the parallel virtual machine in a Unix shell script, which also ensures the proper termination of the distributed computing system. Although this first cut at a parallel architecture for the NPARC flow simulator needs additional optimization in the areas of message passing efficiency and load balancing, it has worked well in practice with appreciable efficiency gains.

Several other enhancements were also made during the course of development of this new version of the NPARC flow simulation program. In particular, the Spalart-Alarmas turbulence model was added to the turbulence model library in the NPARC program. Also, the requirement to specify at compile time most of the computer storage needs for each different application of NPARC has been removed.

While not trivial, parallelization of an existing flow simulation program, such as NPARC, is quite possible and desirable. However, this is just the

first step as the efficiency of the implementation is not automatically assured. Current experience with the parallel version of the NPARC code bears both of these assertions out.

WWW Update

We've been a little slow in updating the NPARC WWW server but the enhancements included in the June update are well worth looking at. The primary cause for the delay in updating the server has been associated with clearance of the presented material for public release. While the material itself presented no clearance problems, presentation of information via the WWW poses unique challenges and issues for clearance processing at government organizations such as the Arnold Engineering Development Center. However, with the clearance process now well in hand future updates should be more timely and more frequent. In the current update be sure to look for the following:

- Overall look and structure of the NPARC WWW server updated.
- NPARC Technical Report Server (NPARC_TRS) updated with 13 references; primarily papers presented at the AIAA Aerospace Sciences Meeting in Reno, NV, (January 15-18,1996).
- First edition of the NPARC Application Summaries added.
- The FY96 Policies and Plans document added.
- Several entries added to the Validation Archive.

The URL is:

http://info.arnold.af.mil/nparc.

Archive Update

With the recent update to the NPARC WWW server, a number of cases have been added to the Validation Archive. The Archive is divided into three major subsets of information, **'Model'**, '**Example'**, and '**Check'** cases and currently contains approximately 220 Mbytes of information distributed over 8 separate entries. These entries include:

Model

- Laminar flat plate flow
- Turbulent flat plate flow
- Subsonic turbulent diffusing pipe flow

Example

- Supersonic axisymmetric jet flow
- Glancing shock/turbulent boundary layer interaction flow
- Turbulent flat plate flow
- Subsonic S-duct inlet flow
- Transonic diffuser flow

Check

- This category is currently under construction.

The archiving and presentation of Validation data sets for CFD is an activity which is not unique to the NPARC Alliance - numerous other organizations are exploring the establishment of a similar activity. Thus, with this update to the Archive we have provided links to a number of other archive sites. In the future, the Alliance hopes to work collaboratively with some of the other organizations providing services to establish a consistent technique for the presentation of this information thus permitting each agency to complement the effort of the others. Lastly, by the '97 Aerospace Sciences Meeting in Reno, the Validation Team will have available for distribution Validation Documentation Guide and a Validation Archive. We intend for these documents to provide the necessary information to permit the submittal of validation cases (Model, Example and/or Check) by organizations outside the Alliance for inclusion in the Archive thus greatly expanding our base for validation demonstrations.

User Association Meetings

The NPARC User's Association meeting at the AIAA Aerospace Sciences meeting on January 15, 1996 was attended by about 40 users, developers, and software vendors. The meeting consisted of an overview of the Alliance, '95 progress, '96 plans, a user discussion, the Alliance position on the System vs. Solver issue, and an open forum session.

Notable '95 progress included the release of version 2.2 along with new documentation and the progress towards the completion of version 3.0 and it's added features (see included article for details). FY95 survey results were presented by Dr. Kyle Cooper.

A presentation was given by Boeing's Propulsion Chief Engineer, J. Syberg, ***Boeing Perspective on NPARC as a Flow Analysis System.*** Syberg strongly supported increased emphasis by the Alliance toward providing an analysis system based on NPARC rather than continuing to focus on just the development of the code.

The open forum discussion was mainly focused on the system vs. solver issue. The Alliance invited several software vendors to attend the user's meeting. In attendance were representatives from ICEM CFD, a grid generation package which has an NPARC interface, Intelligent Light, Inc., the developers of a flow visualization

package called Fieldview which supports PLOT3D file formats, and EnSight, another flow visualization package which also supports PLOT3D file formats. The vendors were introduced to the potential market of their tools to several hundred NPARC users if their software packages are compatible with both the NPARC code and current CAD systems.

There were also two NPARC sessions at the Aerospace Sciences Meeting. featuring NPARC developments and applications from a wide range of users. The paper numbers are 96-0382, 96-0383, 96-0384, 96-0385, 96-0386, 96-0387, 96-0493, 96-0495, 96-0496, 96-0497, 96-0498. Abstracts of each of these papers can be found in the NPARC reference database accessible from the NPARC WWW server.

The following is a list of upcoming NPARC User's Association meetings:

July 1-3, 1996
AIAA Joint Propulsion Conference
Lake Buena Vista, FL

One NPARC Technical Session

January 6-9, 1997
AIAA Aerospace Sciences Meeting
Reno, NV

One NPARC Technical Session

June 1997
AIAA Applied Aerodynamics Conference

Technical Sessions planned

Please plan to attend one of the User's meeting to let your views be known. You are also encouraged to contribute to the NPARC technical sessions to communicate your experiences to other users.

Frequently Asked Questions

The following are some of the more frequently asked questions of the user support team.

Can I use the contiguous block interface B.C. (70) if the grid indices of the two interface planes increment in different directions? Can I use the abutting block B.C. (77) for noncontiguous interfaces?

No, the current implementation of these block interface B.C.'s requires that the interfaces increment similarly and that an exact one-to-one match between grid points exist. We plan to enhance the contiguous block interface boundary conditions to allow this flexibility in the future, but this feature will not be available for version 3.0.

Can NPARC be used for near incompressible flow simulations?

NPARC uses a standard Beam-Warming or Runge-Kutta time-marching technique to integrate the compressible Navier-Stokes equations. Due to the large variation in the magnitude of the eigenvalues (information propagation speed), low speed flow simulations can take a very long time to converge. We are currently working on implementation of a pre-conditioning technique, similar to that developed by Prof. Merkle at Penn State. This approach should significantly enhance the convergence characteristics of low speed flow simulations.

Are there input and restart files available for a case similar to the one I am currently interested in?

Maybe. Check out the validation archive for comprehensive validation data including input files, output files, restart files and experimental data. Application summaries are also available on the WWW. If any of these are similar to a problem of interest, users may want to contact the original author.

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